Operating California nuclear plants

Steam generator replacements -- understanding the costs, benefits and risks of "unexpected surprises"

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Are Steam Generator replacements cost effective?

Too cheap to meter, or too costly to bear

San Onofre SGRP

- ↓ SCE's initial claim -- net benefits of $820 million to $1.1 billion.
- ↓ Base case after hearings -- $146 million.
- ↓ Total revenue requirements -- $8 billion.
- ↓ SONGS transmission mitigation benefits likely overstated.
- ↓ Significant net negative benefits occur in the event of a single adverse development.
- ↓ TURN believes SONGS SGRP is not cost-effective.

Diablo Canyon SGRP

- ↓ PG&E's initial claim -- net benefits of $1.2 billion.
- ↓ CPUC found that the most likely scenario resulted in net benefits of -$49 million to +$591 million.
- ↓ Serious doubts about PG&E's modeling. Substantial future uncertainties and unrealistic assumptions create large ratepayer risks.

Prospective cost assumptions

San Onofre

- ↓ Steam generator replacement cost estimates do not contemplate any possible cost overruns despite the uniqueness of the project.
- ↓ Future O&M costs estimates escalated during the course of SONGS proceeding
  - *Original Base O&M* *$284.3 million/year*
  - *SONGS high case* *$341.16/year*
  - *SCE opposes consideration of cost escalation above "high case"*
  - *2006 GRC forecast* *$310 million/year*
    (new NRC security requirements)
- ↓ Increase in capital cost forecasts during proceeding, including higher expenditure forecasts presented to SONGS BOR in January 2005.

Diablo Canyon

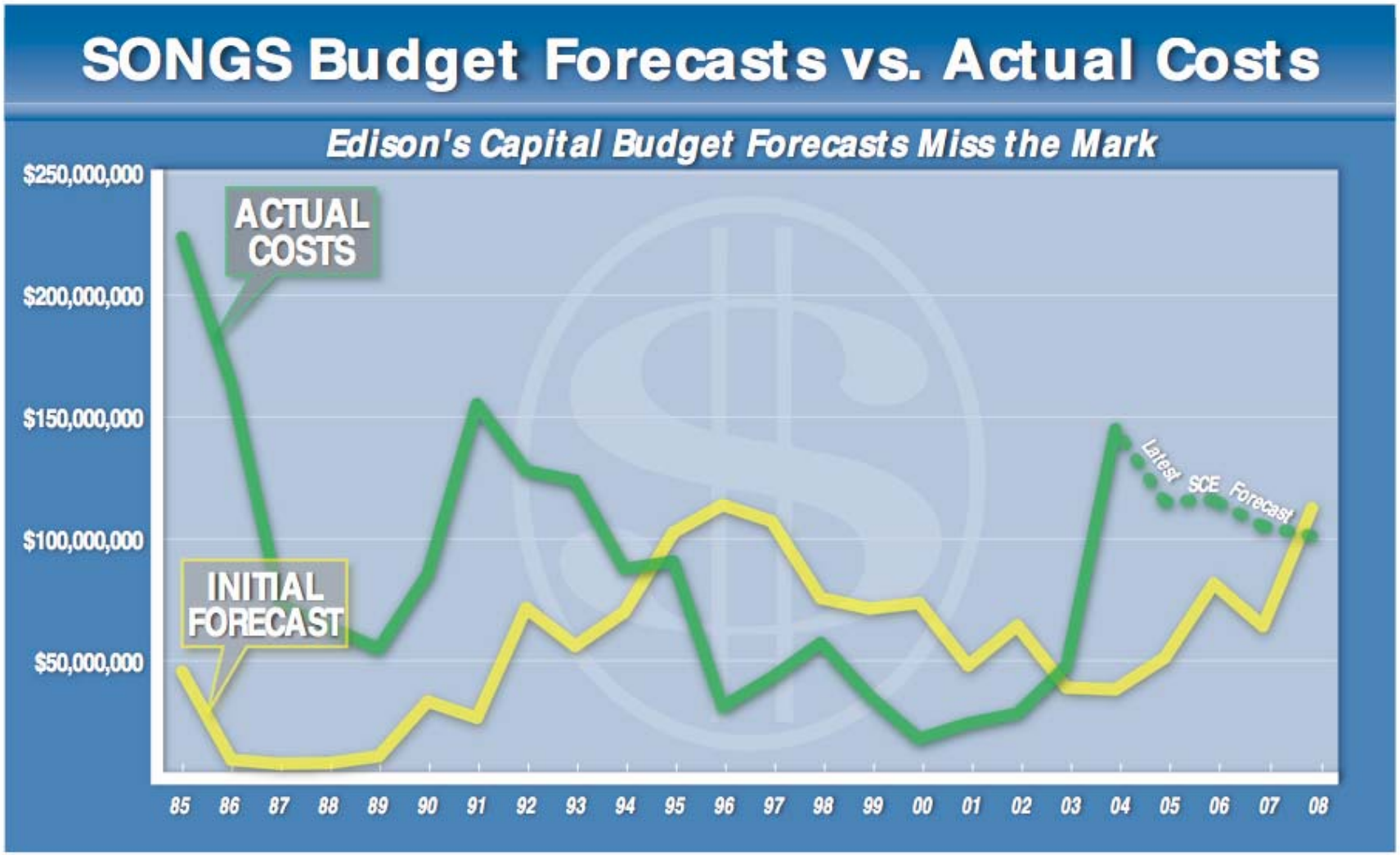
- ↓ PG&E estimate $706 million – CPUC adopts $815 million "cap".
- ↓ PG&E anticipates a "drastic reduction in the capital needs of the plant" once all currently foreseen projects are completed – assumes that incremental capital projects decline to zero post-2015.

SONGS past and future

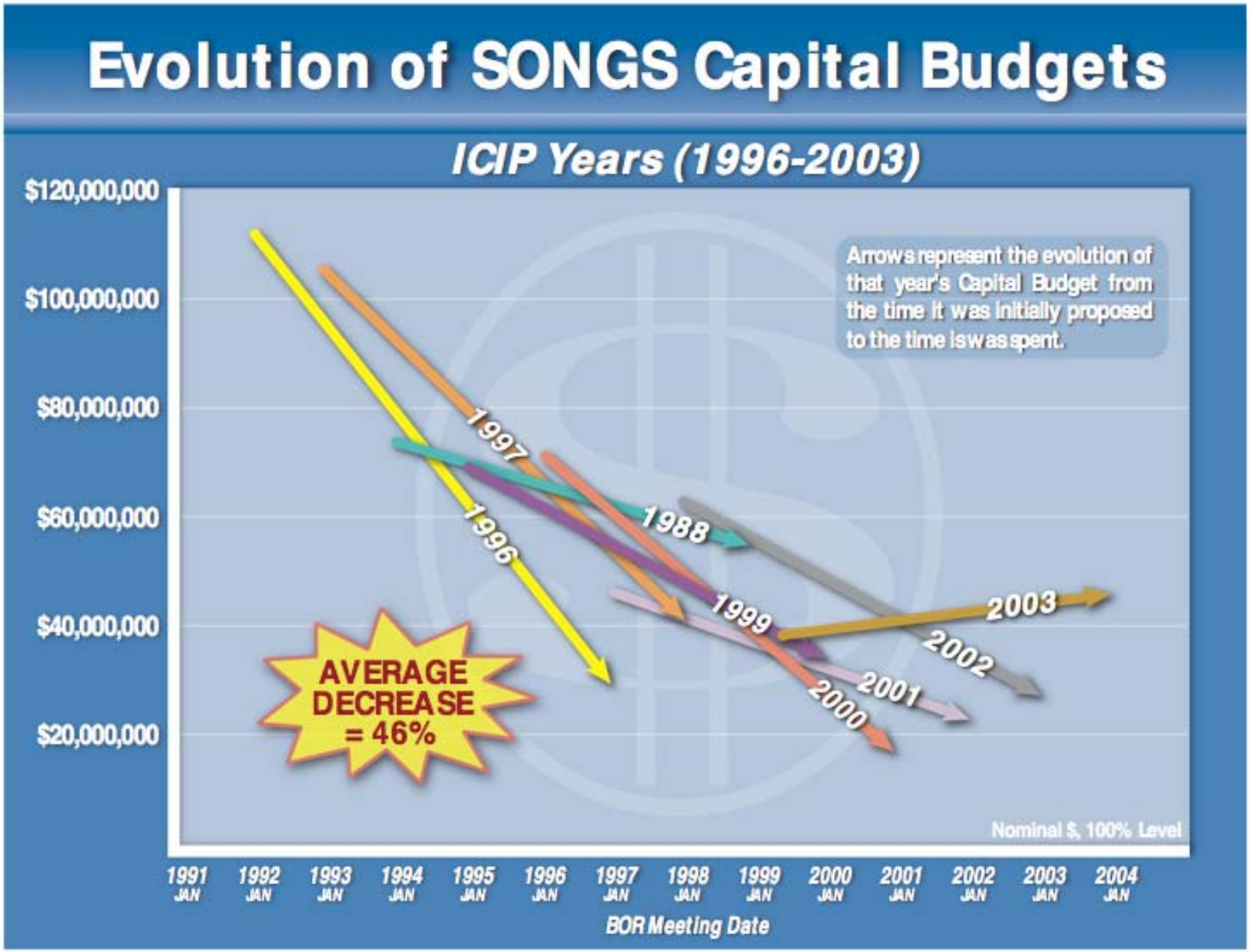
experiences with forecasted vs. actual expenditures

Will history repeat itself?

SONGS Budget Forecasts vs. Actual Costs



Evolution of SONGS Capital Budgets



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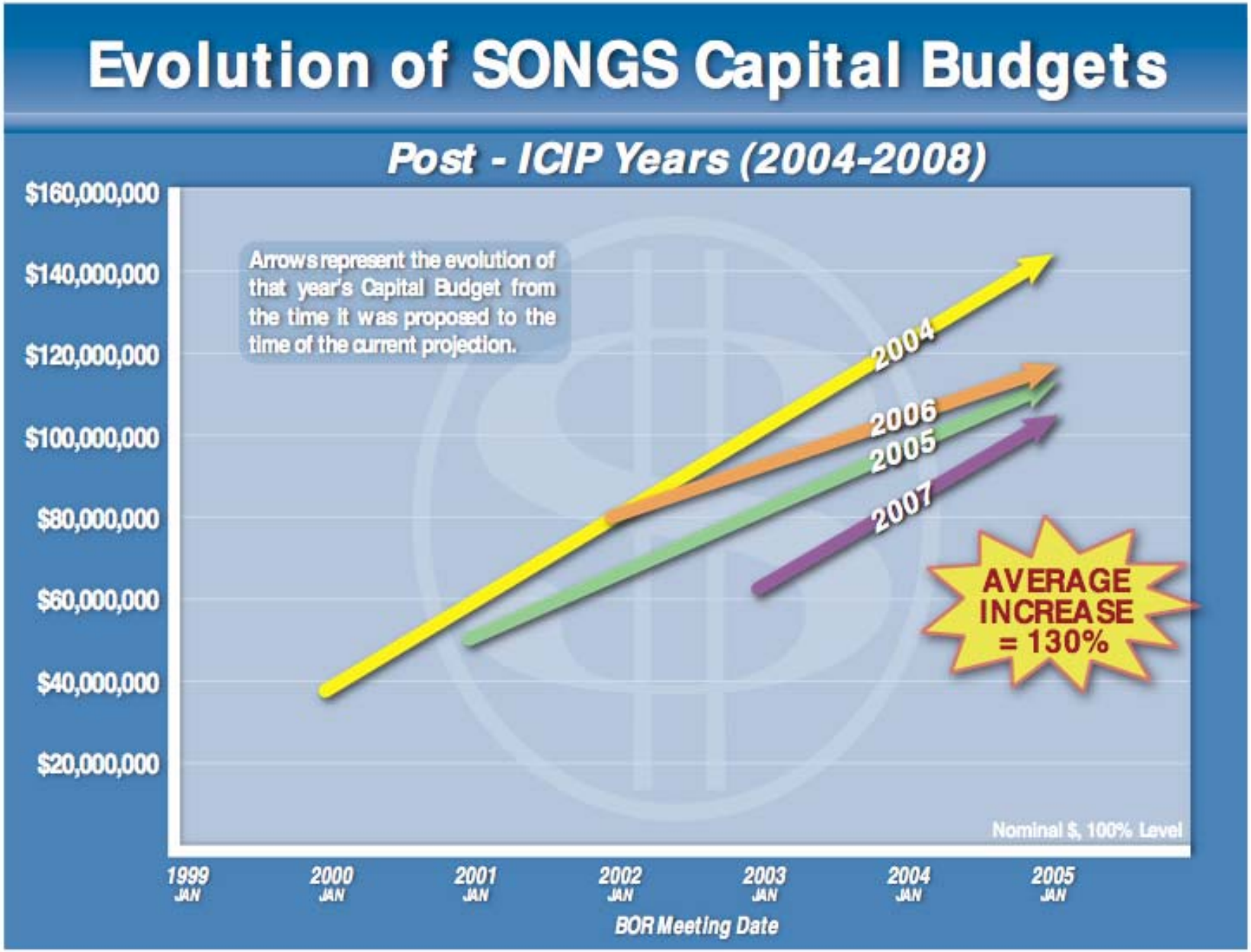
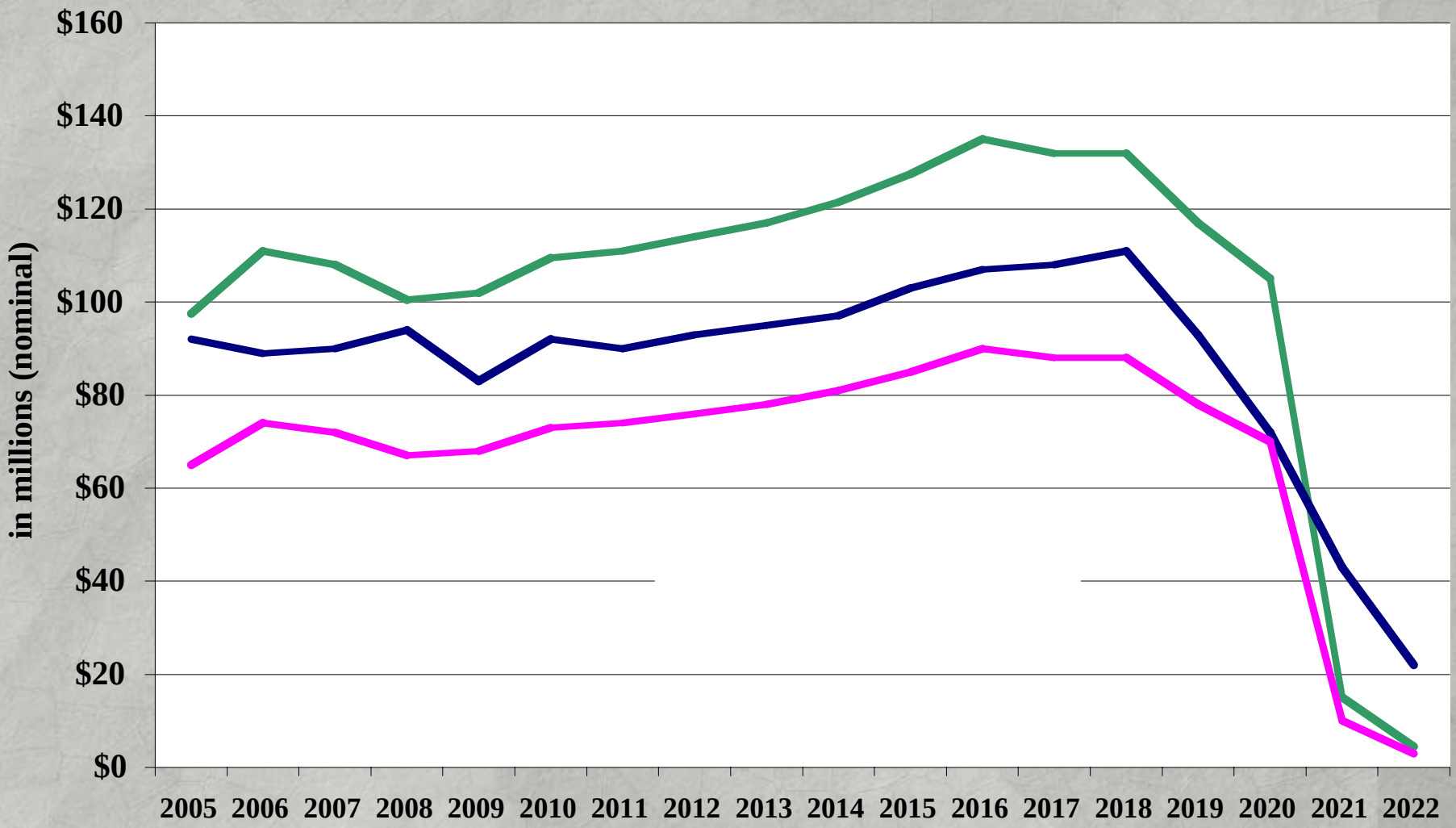


SONGS Capital Forecasts



Economic risks of nuclear power

Specific to the plants

- ↓ Unanticipated capital and O&M expenditures
- ↓ Lower capacity factors
- ↓ New regulatory requirements (safety, terrorism)
- ↓ Potential extended shutdowns
- ↓ Extended outages
  - ↓ *PG&E model assumes 0% chance of an outage with new SGs.*
- ↓ Catastrophic accident
  - ↓ *SCE/PG&E assume 0% chance*
- ↓ Life of unit (license renewal)

External factors

- ↓ Gas price volatility
- ↓ Bundled retail load uncertainty – if direct access reopens, do these units become stranded?
- ↓ Technological innovation may drive down costs of newer clean technologies
- ↓ Ongoing uncertainty over radioactive waste storage

Unexpected Surprises

"when bad things happen to good power plants."

- **Reactor vessel head replacement** never anticipated until problems discovered at Davis Besse
- **Steam generator replacements** at SONGS/Diablo not projected prior to last five years
- **Reactor coolant pump cracking** concerns arose in past five years
- **PWR containment sump failure** – Diablo and SONGS affected
- **New security requirements** post-9/11 and beyond
- **Risk of terrorist attack** at SONGS/Diablo or elsewhere in US
- **Catastrophic accident** causing economic losses, health and environmental damages.
- **Unplanned extended outage**
  - *16 domestic nuclear plants experienced outages of greater than 12 months since January 1, 1990. At least another six units have been shutdown for outages of between nine and twelve months in duration during this same period.*

Ratepayer benefits guarantees

- **Net benefit guarantee proposed by Aglet and TURN in Diablo and SONGS proceedings.**
  - Minimum net benefit calculation applied over remaining unit life. IOU shareholders would guarantee ratepayers at least 50% of the total benefits adopted in the final decision.
  - Protections against poor forecasting, cost escalation, unexpected surprises, mismanagement.
  - Creates pressure for cost containment.
- **Bundled customer protections**
  - Customers currently on bundled service who subsequently leave for direct access should be obligated to pay any stranded costs.
- **Desire to secure ratepayer protections, create incentives for efficient (and safe) operations, and prevent windfalls**

Steam Generator design defects are the cause of premature replacement

- Steam generators fabricated with 40-year design life
- Key design defect -- susceptibility of Alloy 600 Mill Annealed (MA) and High Temperature Mill Annealed (HTMA) to a variety of degradation mechanisms including denting, primary water and outside diameter stress corrosion cracking (SCC) and intergranular attack (IGA)
- By 1984, 64 of 71 PWRs operating for more than five years had experienced steam generator corrosion problems
- Based on industry experience and plant-specific studies, PG&E and Edison knew that their steam generators were very unlikely to remain in service for the remainder of the 40-year operating license life
- In 1985, CPUC directed SCE/SDG&E to seek compensation from Westinghouse for SONGS Unit 1
  - *"it is not acceptable for a regulated utility to look to ratepayers as a deep pocket of first resort when it arguably has an adequate remedy at law against the manufacturer of a defective product." (D.85-03-037)*

California utilities fail to litigate against vendors of original steam generators

Déjà vu all over again

- PG&E and SCE had breach of warranty and fraud claims but took no actions to secure compensation from steam generator vendors (Combustion Engineering and Westinghouse).
- Steam generator defects led to higher repair, inspection and maintenance costs along with the need for premature replacement.
- Compensation obtained by other utilities
  - Settlements for 9 of 13 Combustion Engineering units (including Palo Verde in 1995). Only SONGS and Millstone 2 owners are replacing steam generators without seeking any compensation from CE.
  - Compensation for 35 of 50 Westinghouse units. 10 remaining units manufactured with Alloy 600 TT (Thermally Treated) tubing, none of which required replacement. PG&E amongst the owners of the remaining 5 units.
- PG&E and SCE failed to provide any defense of their inaction and refused to respond to discovery requests.
- Both PG&E and SCE should be subject to disallowances to reflect compensation that could have been obtained from vendors had the utilities acted reasonably on behalf of ratepayers.

Lessons learned?

- **Nuclear risks are different**
  - Low probability/high consequence events difficult to model
  - Unexpected surprises complicate economic decisionmaking -- every investment considered in isolation
- **Ratepayers should not be the perpetual deep pockets guaranteeing nuclear risks**
- **Utilities must be held responsible for failure to pursue ratepayer interests, poor unit performance, and higher than expected costs**
- **Nuclear retirements should be considered**